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Measures of the Polar Diameter and of the Principal Belts, and of Two Dark Spots on Jupiter, and of the Satellites and their Shadows in Transit, made at Mr. Crossley's Observatory, Bermerside, Halifax, during the Apparition of 1895–96. By Joseph Gledhill.

MEASURES OF THE POLAR DIAMETER.

The following results were obtained in four ways—A, by direct measures of the polar diameter of the apparent disc; B, by measures of the distances of satellites and shadows in transit from the poles of the disc; C, by measures of the distances of dark spots in transit from the two poles; D, by measures of the distances of the principal dark bands from the two poles.

In every case the micrometer was set to the computed position angle of *Jupiter's* equator as given by Mr. Marth.

The instrument used was the $9\frac{1}{3}$-inch Cooke equatorial refractor, with the parallel-wire micrometer by Simms, power 282.

A.

Under *a* is given the number of measures; under *b* the diameter; *m* measured, M Mr. Marth's value (both to the nearest tenth of a second); and under *c* the difference between *m* and M.

		b		*c*			*b*		*c*
	a	*m*	M			*a*	*m*	M	
1896.		″	″	″			″	″	″
Feb. 26	12	42·3	42·0	+0·3	Apr. 21	7	35·9	35·8	+0·1
Apr. 11	6	36·6	36·9	−0·3		6	36·1	35·8	+0·3
12	5	36·8	36·8	0·0	22	5	35·8	35·7	+0·1
13	8	36·4	36·7	−0·3	23	10	35·6	35·6	0·0
15	9	36·3	36·5	−0·2	24	5	35·6	35·5	+0·1
16	6	36·1	36·3	−0·2	26	6	34·9	35·3	−0·4
18	7	36·1	36·1	0·0	28	7	35·1	35·0	+0·1
20	5	36·0	35·9	+0·1	29	5	34·7	34·9	−0·2

The mean difference, regardless of sign, is nearly 0·″2.

B.

Feb. 23	39	43·0	42·2	+0·8	Apr. 3	2	38·1	37·8	+0·3
Mar. 18	9	40·0	39·7	+0·3	6	20	37·7	37·5	+0·2
19	2	39·5	39·6	−0·1	20	4	36·6	35·9	+0·7

The mean difference is 0·″4.

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C.

		b		*c*			*b*		*c*
	a	*m*	M			*a*	*m*	M	
1896.		″	″	″			″	″	″
Feb. 26	3	43·0	42·0	+1·0	Mar. 18	2	39·7	39·7	0·0
	5	42·6	42·0	+0·6	23	6	38·9	39·2	−0·3
Mar. 9	6	41·4	40·8	+0·6	30	2	37·8	38·3	−0·5
15	4	39·4	40·1	−0·7	Apr. 11	4	36·6	36·9	−0·3

The mean difference is 0″·5.

D.

Mar. 9	4	40·2	40·8	−0·6	Apr. 18	6	36·4	36·1	+0·3
12	8	39·8	40·4	−0·6	20	6	36·4	35·9	+0·5
23	7	39·2	39·2	0·0	21	6	36·1	35·8	+0·3
30	3	38·3	38·3	0·0	22	6	35·9	35·7	+0·2
Apr. 3	4	37·8	37·8	0·0	23	6	35·6	35·6	0·0
9	6	37·5	37·1	+0·4	24	7	35·6	35·5	+0·1
10	5	37·6	37·0	+0·6	26	5	35·2	35·3	−0·1
11	5	36·6	36·9	−0·3	28	5	35·1	35·0	+0·1
12	6	36·5	36·8	−0·3	29	4	34·8	34·9	−0·1
13	6	37·1	36·7	+0·4	May 6	5	34·1	34·2	−0·1
15	6	36·6	36·5	+0·1					

The mean difference is 0″·24.

The computed values are for noon of each day, and are taken from Mr. Marth's ephemerides.

With regard to the atmospheric conditions prevailing when the above observations were made, it should be said that on no occasion were they really good, and rarely fairly good. It is only when mist or thin cloud prevails that steady images are obtained here.

MEASURES OF THE POSITION ANGLE OF THE NORTH AND SOUTH EDGES OF THE BRIGHT EQUATORIAL ZONE OF JUPITER.

The strongly-marked double dark band just south of the equator was used in the earlier measures, and the narrow dark band just north of the equator in the later measures. After adjusting the parallel-wire micrometer on a bright and a fainter star near the meridian, the position webs were placed parallel to one of the belts just named.

In column *a* are given the means of from three to five measures; in column *b*, the position angle of the equator, from Mr. Marth's ephemerides. Power 282 was always used.

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1896.	a	b		a	b
	°	°		°	°
Mar. 23	103·2	103·7	Apr. 18	104·2	104·0
Apr. 3	103·3	103·7	23	104·0	104·2
9	103·9	103·8	24	104·3	104·2
11	103·7	103·8	26	104·1	104·3
13	103·8	103·9	29	105·1	104·4
15	104·1	103·9	May 11	105·0	104·9
16	104·3	104·0			

These bands, therefore, are sensibly parallel to *Jupiter's* equator.

MEASURES OF THE POSITION, &c., OF THE PRINCIPAL BELTS.

The salient features lately visible on the planet *Jupiter* are perhaps best described by using the terminology adopted by the *British Astronomical Association*, viz. the North Temperate Band, the North Equatorial Belt, the South Equatorial Belt, the South Temperate Band; these are the dark bands or belts. The bright zones are called the North Tropical Zone, the Equatorial Zone, and the South Tropical Zone. There are other fainter bands and narrower zones, but of these nothing will be said in this paper.

It was with the object of determining the latitudes of the principal belts that the measures about to be given were made. And it soon became obvious that to do this with great accuracy careful work on really good nights would be required. The present paper is the result of an attempt to do this under the best observing conditions experienced here since January last. And it may at once be said that the definition and steadiness of the image were never of the best quality.

The measures were all made with the $9\frac{1}{3}$-inch Cooke equatorial refractor and the Simms parallel-wire micrometer; power, 282.

No attempt was made to *measure* the width of the narrow bands; the webs were set apart to the estimated width, and then brought near the bands for comparison.

On trial it was found that Mr. Marth's position angle of the polar axis of *Jupiter* plus 90° brought the adjusted web of the micrometer into a position parallel to the equatorial belts. Hence the method adopted was to set the position circle to its zero reading, clamp it, and then adjust the micrometer by a bright and a faint star near the meridian; then, lastly, move the vernier to the reading for the Jovian equator, and again clamp the position circle.

The value of one revolution of the micrometer screw is $13''\cdot837$; one division of the divided head $=0''\cdot138$. One web was placed on the edge or middle of a band, the other just on the north limb of *Jupiter*; the web was then carried to the other

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side of the fixed web, and the measure repeated. Similarly for the south limb.

The Polar Shading.

The dusky regions near the poles were not critically examined, but taken as a whole, and the distances of the north and south edges from the south and north poles of the disc were measured. No doubt the extent of this shaded part of the disc is not quite the same in all longitudes, and this fact may be indicated by the differences in the few results here given.

1896. d	h		″		″
Feb. 12	11	width of N. shading	= 6·4 ;	of S. shading	= 7·3
26		„ „ „	7·0 ;	„ „	7·0
Mar. 9		„ „ „	7·7 ;		
Apr. 24		„ „ „	6·6 ;	„ „	6·6

These are reduced to $\Delta = 5{\cdot}20$.

The North Temperate Band.

As an illustration of the kind of accordance obtained from night to night the following extract from the note books is given :—

1896	h	″	″	″
April 10	7½	+8·0	+7·9	+0·3
11	8	7·4	7·3	−0·3
12	8½	7·4	7·3	−0·3
13	8	7·9	7·8	+0·2
15	8	7·6	7·5	−0·1
16	8	7·4	7·3	−0·3
20	8	+7·9	+8·0	+0·4

where the distance of the middle of the band from the equator is given in the third column ; the fourth column gives the distances reduced to $\Delta = 5{\cdot}20$, and the fifth the differences from the mean of all.

1896		″	Latitude °	
Feb. 26 to Apr. 13	...	+7·25	+24·3	10 nights
Apr. 15 to Apr. 24	...	7·63	25·7	7 „
Apr. 26 to May 10	...	7·36	24·7	5 „

The mean of all $+7''{\cdot}4$, and $24^\circ{\cdot}9$. The width of this band varies in different longitudes ; it has never been a conspicuous band since 1895 October, and it was often difficult to see distinctly enough for a good measure.

Its breadth ranges from about $1\tfrac{1}{2}''$ to $2\tfrac{1}{2}''$, the mean of one set of 5 nights' measures being $2''{\cdot}3$, and of another similar set $1''{\cdot}7$.

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The North Equatorial Belt.

This is a narrow and comparatively inconspicuous belt in all longitudes, and was seldom well seen. The reduced measures are—

			Width.	
+2″·2	+7°·7	10 nights		
+2·5	+8·6	10 "	1″	5 nights
+2·6	+8·8	10 "	1″	5 "

The means are +2″·4 and +8°·3.

The South Equatorial Belt.

This has been the most salient feature of the planet throughout the present apparition, and could be well seen through terrestrial clouds of considerable density. It is double in all longitudes if we except the small portion just under the Red Spot, where it becomes single.

The middle of the band :

			Means
−4″·0	−13°·1	10 nights	−3″·9 and −13°·1
−3·9	−13·1	10 "	

The north edge :

			Means
−2″·32	−8°·2	9 nights	−2″·2 and −7°·7
−2·27	−7·8	9 "	
−2·1	−7·2	5 "	

The south edge :

			Means
−5″·76	−19°·3	10 nights	−5″·7 and −19°·1
−5·72	−19·0	10 "	

Width of this double band :

3″·5	10 nights	Mean = 3″·5
3·5	10 "	
3·5	10 "	

At its narrowest part, just under the Red Spot, the width is about 1″.

The South Temperate Band.

This was not often seen very distinctly.

−8″·7	−29°·4	10 nights

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The North Tropical Zone.

Its width :—

3″·2	5 nights	Mean = 3″·1
3·0	5 „	
3·2	5 „	

The Bright Equatorial Zone.

3″·8	5 nights	Mean = 3″·6
3·6	5 „	
3·3	5 „	

It is possible that some of the discordance in some of the above measures for latitude may arise either from actual differences in latitude of the belt in certain longitudes, or from drift in latitude since the observations began. For a full discussion the longitude of each night's measures would be needed; the longitude was recorded, but it has not been thought necessary to give it. At any rate the question of drift has already become an interesting and important element in the study of the physical features of *Jupiter*. And the following extracts (especially that from the admirable series of measures by Professor Hough) will be read with interest (see the *Annual Reports of the Dearborn Observatory*; also *The Observatory*, vol. iv. p. 325, and the *Astronomische Nachrichten*, vol. cxl. p. 169 and p. 273) :—

	1811	1876	1880
South pole to 1st belt ...	13″·60	15″·54	15″·94
„ 2nd „ ...	20·60	19·71	19·34
„ 3rd „ ...	23·67	22·57	24·55
„ 4th „ ...	29·12	28·96	31·86

The measures under 1811 were by Arago, in 1810–13; those in 1876 and 1880 by Russell. Latitude of first belt is −36° to −38°; of second, −18°; of third, +18°; of fourth, +36° to +38°.

Dr. L. de Ball has, for 1884–5, the following results :—

N.P.D. of middle of great south belt	21″·9
„ „ north „	14·0
S.P.D. „ south „	15·1
„ „ north „	22·0

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Professor Hough's measures are, for the north and south edges of the equatorial zone—*

	1879	1880	1881	1882	1883	1884	1890
	″	″	″	″	″	″	″
North edge	+2·59	2·33	2·16	2·44	2·58	4·95	4·52
South edge	−4·18	4·71	4·75	6·36	5·80	4·69	
Width	6·77	7·04	6·91	8·80	9·30	10·03	9·49

Lastly, the following latitudes, by Dr. E. Lamp, have just appeared in the *Astronomische Nachrichten* (vol. cxl. p. 169); they are for 1896 March:—

			°
North edge of north temperature band	...	+	25·9
South „ „	...	+	21·7
North „ equatorial band	...	+	6·0
South „ „	...	+	2·0
North „ south „	...	−	5·0
South „ „	...	−	16·8
North „ temperate band	...	−	28·5
South „ „	...	−	34·1

OBSERVATIONS OF TWO DARK SPOTS SEEN ON ONE OF THE BRIGHT ZONES OF JUPITER.

In the early morning hours of 1895 October 30 an elongated dark spot was noticed near the north edge of the north equatorial belt and in the bright north tropical zone. It was quite detached from the belt; its length was about 2½″, breadth about 1¼″, with the longer axis parallel to the dark belt. At the time of its transit across the central meridian its Jovicentric longitude was about 222°. It passed the central meridian of the disc about $3^h\ 47^m$ before Mr. Marth's zero meridian, and is the *grey spot* of the following notes.

Another spot of about the same size and shape, but much darker, was not noticed here until 1896 January 28; it was in longitude 269°, passed the central meridian about $2\frac{1}{2}^h$ before the zero meridian in the same latitude as the grey spot, and is the *dark spot* of the following notes.

A few measures of the length of the *dark spot* were made, but, as the earlier ones differ so much from those made in April of this year, I suspect the accuracy of the former; however, here they are:—1895 November 13, 2″·4; 1896 January 30, 2″·5; February 23, 1″±; March 9, 1″·2 (width, ½″+); April 23, 1″·5; April 20, 1″·7; April 28, 1″·4 (width, 1″).

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* By *Equatorial Zone* Professor Hough means the north equatorial belt, the south equatorial belt, and the bright zone (equatorial) between them. (See *Ast. Nach.* vol. cxl. p. 273.)

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The following tables give a complete list of the transits of the spots :—

The Grey Spot.

G.M.T. of Transit.				λ		G.M.T. of Transit.				λ	
1895	d	h	m	°		1896.	d	h	m	°	
Oct.	29	17	5	222·0	Good.	Feb.	9	6	14·5	197·0	Poor.
Nov.	11	12	47	220·0	Good.		12	13	37·5	196·3	Fair.
	13	14	23	219·3	Fair.		22	11	49·5	196·0	Poor.
	17	7	43	216·5	Good.		23	7	43	195·5	Fair.
	18	13	31	218·0	Poor.		25	9	21	195·2	Poor.
	30	13	15	218·0	Bad.	Mar.	15	10	3	195·9	Poor.
Dec.	19	13	49·5	212·0	Good.		18	7	33	196·0	Poor.
1896.						Apr.	18	7	55·5	184·5	Fair.
Jan.	28	6	35	204·9	Poor.		20	9	27	180·1	Fair.
Feb.	3	11	29	204·8	Bad.		25	8	39	181·8	Good.
	6	8	50·5	200·3	Poor.		30	7	50	182·5	Good.

The first column gives the G.M.T. of the spot's transit over the apparent central meridian ; the second gives the Jovicentric longitude of the spot at central transit ; the last gives an estimate of the quality of the observation at the time.

The Dark Spot.

G.M.T. of Transit.				λ		G.M.T. of Transit.				λ	
1896.	d	h	m	°		1896.	d	h	m	°	
Jan.	28	8	21	268·9	Poor.	Mar.	18	9	20	260·6	Fair.
	30	9	58	268·3	Fair.		23	8	22	258·5	Bad.
Feb.	6	10	41	367·0	Poor.		25	9	57	254·3	Poor.
	9	8	6	264·5	Poor.		28	7	30	256·1	Poor.
	11	9	40	262·0	Fair.		30	9	9	256·3	Fair.
	14	7	16	266·0	Poor.	Apr.	9	7	23	254·0	Fair.
	23	9	35	263·1	Fair.		11	8	58	252·0	Poor.
	24	5	30	265·4	Poor.		16	8	6	250·7	Fair.
	26	7	6	263·4	Fair.		18	9	45·5	251·9	Fair.
Mar.	1	10	15	259·4	Fair.		20	11	29	253·8	Fair.
	4	7	48	261·5	Fair.		23	8	54	250·6	Good.
	6	9	25	260·6	Poor.		28	8	3	250·1	Fair.
	8	11	5	261·0	Poor.		30	9	43	250·7	Fair.
	9	6	55	260·7	Fair.	May	5	8	50·5	249·6	Good.
	16	7	43	261·6	Poor.		10	8	0	249·2	Good

Taking observations not less than about ten days apart the following series of ten is obtained :—

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The Dark Spot.

Observed G.M.T. of Transit.				λ	L	Δ	R
1896.	d	h	m	°	°		
Jan.	28	8	21	268·9	123·6	4·30	0
Feb.	14	7	16	266·0	121·9	4·37	41
	26	7	6	263·4	120·3	4·47	70
Mar.	4	7	48	261·5	119·8	4·55	87
	16	7	43	261·6	119·2	4·69	116
	25	9	57	254·3	119·1	4·82	138
Apr.	9	7	23	254·0	119·5	5·07	174
	23	8	54	250·6	120·4	5·28	208
	30	9	43	250·7	121·1	5·39	225
May	10	8	0	249·2	119·8	5·54	249

where λ is the Jovicentric longitude of the spot, L the geocentric longitude of *Jupiter*, Δ the distance of the Earth from *Jupiter*, and R the number of rotations.

A few trials showed that a period of $9^{h}\ 55^{m}\ 30^{s}$ very nearly represented the observations. This was adopted as the assumed period. The observations were then corrected for longitude and aberration, all being reduced to geocentric longitude 125° and to $\Delta = 5{\cdot}20$; and thus the corrected times were obtained.

Putting a for the error of the first aberration, ρ for the correction of the assumed period, T for the corrected time of an observation, and T_0 the corrected interval between any observation and the first, the equations of condition take the form

$$a + N\,(595^{m}{\cdot}5 + \rho) = T - T_0.$$

N = the number of rotations.

From the ten equations of condition the two normal equations were derived and solved, and the following values resulted :

$$a = -0^{m}{\cdot}67 \qquad \rho = +0^{m}{\cdot}05.$$

Hence the period is $9^{h}\ 55^{m}\ 33^{s}$.

With the help of the Greenwich Mean Times when the zero-meridian passed the middle of the illuminated disc (given in Mr. Marth's ephemerides) in the assumed System II., the period of rotation is very readily found when the observed times of transit of the spot are known, and the value thus obtained is identical with that just given.

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The Grey Spot.

			λ	L	Δ	R
1895. d	h	m	°	°		
Oct. 29	17	5	222·0	128·0	5·2	0
Nov. 11	12	47	220·0	128·8	5·0	31
Dec. 19	13	49·5	212·0	128·2	4·5	123
1896.						
Jan. 28	6	35	205·0	123·6	4·3	219
Feb. 25	9	21	195·0	120·4	4·5	287
Mar. 15	10	3	196·0	119·3	4·7	333
Apr. 18	7	55·5	184·0	119·7	5·2	415
30	7	50	182·0	121·1	5·4	444

Correcting as before, reducing to $L = 130^\circ$ and $\Delta = 5{\cdot}20$, forming the equations of condition, and solving the two normal equations, the period is found to be $9^h\ 55^m\ 32^s$.

The Latitude of the Spots.

The distance from the centre of the dark and grey spots to the north and south poles was measured on every fine night between 1895 October 29 and 1896 May 10, the micrometer being set to the computed position angle of *Jupiter's* equator. The first measures, made when the planet was low and the motion very great, viz. in 1895 October and November, gave a mean distance of $4\frac{1}{2}''$ from the Equator north.

This distance is probably in excess of the true value. The following is a complete list of the results derived from the measures from January 30 to May 10, 1896. Under *a* are given the distance from the Equator; Δ is the distance of the planet from the Earth; B is the B of Mr. Marth's ephemerides; and *b* gives the values under *a* reduced to $\Delta = 5{\cdot}20$.

a	Δ	B	*b*	*a*	Δ	B	*b*
″		°	″	″		°	″
+4·4	4·31	+0·48	+3·6	+4·5	4·79	0·59	4·1
4·4	4·33	·50	3·6	4·6	4·90	·59	4·3
5·6	4·36	·52	4·7	4·2	5·05	·58	4·1
5·5	4·37	·52	4·6	4·2	5·09	·58	4·1
4·4	4·44	·54	3·7	4·3	5·20	·57	4·3
4·6	4·47	·55	3·9	3·8	5·24	·57	3·8
4·5	4·51	·56	3·9	4·4	5·28	·56	4·5
5·2	4·61	·57	4·6	4·3	5·33	·56	4·4
4·8	4·68	·58	4·3	4·5	5·36	·55	4·6
4·4	4·72	·58	4·0	4·4	5·54	·52	4·7

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Taken in groups of five the means are 4″·1, 4″·1, 4″·2, 4″·4; and 4″·2 the mean of all. With the help of Mr. Marth's values of B and the formula

$$\sin(\beta' - B') = \frac{y}{b'},$$

the latitude of the two spots is found to be +14°·2.

The measures seem to indicate a slight increase in the latitude in the period embraced by the observations. Dr. Lamp (*Ast. Nach.* vol. 140, p. 170) gives the latitude +12°·3, 1896 March 23, from micrometric measures of the distance d, from the centre of the planet's disc, "unter Vernachlässigung der Neigung der Bahnebene und der Rotationsaxe des Planeten nach der Formel

$$\tan\phi = \frac{b}{a} \cdot \frac{d}{\sqrt{(b+d)(b-d)}}$$

berechnet."

As it is almost certain that a dark spot seen here in 1894 November is identical with the *Grey Spot*, the following observations will probably have some interest for observers of these phenomena.

1894 November 5.—A dark oblong spot under the north equatorial dark band; central transit about 10^h 58^m.

G.M.T. of Transit.				Before the Zero Merid.		Jovicentric Longitude.	G.M.T. of Transit.				Before the Zero Merid.		Jovicentric Longitude.
1894.	d	h	m	h	m	°	1895.	d	h	m	h	m	°
Nov.	5	10	58	3	19	239·3	Feb.	7	8	9·5	3	31·8	232·3
	15	9	10·5	3	21	238·2		9	9	46	3	33·8	231·1
	17	10	47·5	3	22	237·6		12	7	15	3	34·8	230·6
1895. Jan.	2	8	31	3	28·7	233·8	Mar.	1	6	15	3	39·9	227·6
	21	9	5	3	33·6	231·0	Apr.	15	8	38	3	38·8	228·5
	26	8	16·5	3	30	233·3							

MEASURES OF THE POSITION OF JUPITER'S SATELLITES AND THEIR SHADOWS WHEN IN TRANSIT ACROSS THE DISC.

In the *Monthly Notices* of the Society, Vol. 55, p. 536, Mr. Marth points out "that the most promising means for determining the longitudes of the nodes of the orbits (of *Jupiter's* satellites) with accuracy would be found in micrometrical measurements of the rectangular coordinates of the shadows of the satellites near their mid-transits, if these measurements are made about the times when the planes of the orbits pass through the Sun. Though the opportunities of 1884, and at the next nodal passages in 1890, pointed out in Vol. 50, p. 347, appear to have been neglected, observers ought to be reminded of their opportunities offered during the present apparition of *Jupiter*." See also Vol. 44, p. 241. It was in response to this appeal that attempts have been made here on suitable occasions to measure the rectangular coordinates of Satellite I. and also of the shadows of I. and III.

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It was very soon found that the measurements of the x co-ordinate could have no value owing to the swaying to and fro of the image of *Jupiter* due mostly no doubt to imperfect driving of the clock.

The measures were made with the Simms Parallel-wire micrometer and the $9\frac{1}{3}$-inch Cooke Equatorial Refractor, power 282. The times are in Greenwich Mean Time. 1896 February 23. Clear, calm; fair definition. Ingress of shadow of Satellite III. about $6^{h}\ 11^{m}$; central about $7^{h}\ 57^{m}$; egress at $9^{h}\ 44^{m}$.

The micrometer was carefully adjusted on a bright and then on a faint star, then set to the given position angle and clamped. The measurement went on continuously from $6^{h}\ 30^{m}$ till $9^{h}\ 20^{m}$. In column *a* is given the distance from the centre of the shadow to the S. pole of the apparent disc, and in *b* the distance to the N. pole; *c* gives the sum of these distances; *d* the number of double measures; *e* the difference from the mean.

a	*b*	*c*	*d*	*e*	*a*	*b*	*c*	*d*	*e*
	″	″			″	″	″		
18·4	24·2	42·6	2	−0·5	18·9	24·9	43·8	2	+0·7
17·7	25·2	42·9	2	−0·2	18·3	25·3	43·6	2	+0·5
18·0	24·5	42·5	2	−0·6	18·3	25·3	43·6	2	+0·5
18·0	24·1	42·1	2	−1·0	18·3	25·2	43·5	2	+0·4
18·3	24·2	42·5	2	−0·6	18·4	24·9	43·3	2	+0·2
18·3	24·9	43·2	2	+0·1	18·0	25·3	43·3	2	+0·2
18·0	25·0	43·0	2	−0·1	17·7	24·6	42·3	4	−0·8
18·4	25·3	43·7	2	+0·6	18·0	24·9	42·9	2	−0·2
17·7	24·6	42·3	2	−0·8	18·0	24·8	42·8	6	−0·3
18·0	25·3	43·3	2	+0·2	18·4	25·0	43·4	2	+0·3
18·3	25·9	44·2	2	+1·1	18·4	25·0	43·4	2	+0·3
18·4	25·6	44·0	2	+0·9	17·8	24·7	42·5	6	−0·6

Mean of numbers in column *c* = 43″·1.

All measures are given to the nearest tenth of a second.

1896 April 6: shadow of III. in transit; shadow central about $7^{h}\ 35^{m}$. Position angle 103°·8.

The measures began at $7^{h}\ 10^{m}$ and ended at 8^{h}.

a	*b*	*c*	*d*	*e*	*a*	*b*	*c*	*d*	*e*
″	″	″			″	″	″		
15·9	20·9	36·8	2	−0·9	16·5	21·3	37·8	2	+0·1
16·4	20·7	37·1	2	−0·6	16·4	21·0	37·4	2	−0·3
16·3	20·9	37·2	2	−0·5	16·5	21·4	37·9	2	+0·2
16·7	21·0	37·7	2	0·0	16·7	21·1	37·8	2	+0·1
16·9	21·3	38·2	2	+0·5	16·6	21·4	38·0	2	+0·3
16·7	20·7	37·4	2	−0·3	16·5	21·4	37·9	2	+0·2
16·4	20·9	37·3	2	−0·4	16·8	20·8	37·6	2	−0·1
16·8	21·5	38·3	2	+0·6	16·5	21·5	38·0	2	+0·3
16·7	21·0	37·7	2	0·0	16·9	21·0	37·9	2	+0·2
16·6	20·7	37·3	2	−0·4	17·0	21·0	38·0	2	+0·3

Mean = 37″·7.

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The webs of the micrometer were brought up to the limbs of the planet and then placed just on them. One revolution of the screw=13″·837; one division of the divided head=0″·138; thickness of the web about 0″·2.

1896 March 18: shadow of Satellite I. in transit; ingress 7^{h} 55^{m}; egress 10^{h} 9^{m} 30^{s}; Position angle 102°·5.

When near mid-transit six double measures were made from shadow to N. and S. limbs of *Jupiter*:—

	″	″	″	″	″	″
Distance from N.	20·6	21·2	21·2	21·0	21·0	21·2
Distance from S.	19·4	19·8	19·1	19·1	18·9	19·2
The sums are	40·0	41·0	40·3	40·1	39·9	40·4

Mean = 40″·3. Differences −0″·3, +0·7, 0·0, −0·2 −0·4, +0·1.

The definition being good and the image fairly steady, the following measures of the *x* coordinate were made.

a from W. limb; *b* from E. limb; *c* the sum of *a* and *b*; *d* the number of double measures; *e* difference from the mean.

a	*b*	*c*	*d*	*e*	*a*	*b*	*c*	*d*	*e*
″	″	″		″	″	″	″		″
27·5	15·2	42·7	2	−0·2	21·3	22·1	43·4	2	+0·5
27·0	15·5	42·5	2	−0·4	21·7	22·5	44·2	2	+1·3
27·5	15·5	43·0	2	+0·1	20·3	23·8	44·1	2	+1·2
24·9	17·3	42·2	2	−0·7	17·8	25·2	43·0	6	+0·1
24·9	18·1	43·0	2	+0·1	13·4	30·0	43·4	2	+0·5
24·2	19·2	43·4	2	+0·5	15·2	27·7	42·9	2	0·0
22·1	19·5	41·6	2	−1·6	15·2	28·1	43·3	2	+0·4
20·1	21·4	41·5	2	−1·4					

Mean = 42·″9.

The above measures were made continuously from 8^{h} 25^{m} till 9^{h} 20^{m}.

The shadow moved along the bright central zone at a distance of 1″·7 from the north edge of the ruddy band (double) just south of *Jupiter's* equator.

1896 March 18: Satellite I. in transit; ingress, 6^{h} 52^{m} 25^{s}; egress, 9^{h} $8\frac{1}{2}^{m}$.

This was a dark transit, the satellite appearing as a dusky round spot. When it was central three measures of its distance from the north and three from the south limb were made:—

From north = 21″·4 From south = 18″·1 Sum. = 39″·5.

Three sets of measures from the east and west limbs were made between 7^{h} 47^{m} and 7^{h} 54^{m}:—

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From East Limb.	From West Limb.	Sum.
″	″	″
18·7	23·9	42·6
18·7	24·5	43·2
17·6	23·5	41·1

Mean = 42″·3; differences +0·3, +1·1, −1·2.

1896 April 26 : Shadow of I. in transit ; ingress, $6^{h}\ 27^{m}$; egress, $8^{h}\ 47^{m}$. Position angle 104°·1.

When nearly central (but on east side of central meridian) the following measures were made :—

Distance from North Pole.	Distance from South Pole.	Sum.	Differences.
″	″	″	″
18·0	16·9	34·9	−0·5
18·0	17·0	35·0	−0·4
18·4	17·0	35·4	0·0
18·2	17·3	35·5	+0·1
18·4	16·9	35·3	−0·1
18·8	16·9	35·7	+0·3
18·8	17·0	35·8	+0·4
18·8	17·1	35·9	+0·5
18·4	16·6	35·0	−0·4
18·9	17·0	35·9	+0·5

Mean = 35″·4.

The shadow was central about $7\frac{1}{2}^{h}$. It moved along the bright central zone at a distance of 1″·4 from the north edge of the ruddy double band just south of *Jupiter's* equator.

Observations of Phenomena of Jupiter's Satellites with the $9\frac{1}{3}$*-inch Cooke Equatorial Refractor at Mr. Crossley's Observatory, Bermerside, Halifax, in* 1895–6. By Joseph Gledhill.

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation.	G.M.T. of *N. Almanac.*
1895.				h m s	h m s
Oct. 29	I.	Ec. D.	Fading	15 6	15 7 19
			Bisection ?	15 7	
			Just gone	15 7 40	
	II.	Ec. D.	Fading	16 35	16 35 58
			Bisection ?	16 36	
			Just gone	16 36 50	
Nov. 30	I.	Ec. D.	Fading	11 34	11 36 16
			Bisection ?	11 35	
			Just gone	11 36 41	